Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

PRESENT PROBLEMS IN PLANT ECOLOGY

V. The Relation of the Climatic Factors to Vegetation

PROFESSOR EDGAR N. TRANSEAU
EASTERN ILLINOIS STATE NORMAL SCHOOL

1. *The Recent Advance in Point of View.*—Perhaps the most interesting and important advance that has been made during the last decade in the study of the relation of plants to environment is in regard to the point of view. It is difficult to say just when the movement began, but it is assuredly true that it has only recently gained recognition. To a certain extent the movement has involved the substitution of the ecological for the floristic method in geographic problems involving climate. It has resulted in a general dissatisfaction with the older descriptive methods and has tended toward a better appreciation of the value of exactness both in the delineation of vegetation and the quantitative analysis of environmental complexes. The movement has further brought to our attention the necessity for investigating vegetation processes by experimental methods comparable to those by which plant processes have long been studied. As I see it, however, these are secondary phenomena attending the substitution of dynamic and genetic views of vegetation for the century-old static conception of plant distribution.

Fourteen years ago it was possible for one of the most prominent students of the North American biota to say:[1]

> It appears, therefore, that in its broader aspects the study of the geographic distribution of life in North America is completed. The primary regions and their principal sub-divisions have been mapped, the problems involved in the control of distribution have been solved, and the laws themselves have been formulated.

---

[1] Yearbook, U. S. Dept. Agric., 1894, p. 214.

Such a claim could have been made only for a static system, since a genetic conception of the problem necessarily involves the indefinite postponement of the approach toward a final solution.

The appearance of the classics of Warming and Schimper served to impress all with the inherent complexity of the problem. We are no longer deeply concerned with the discussion as to whether temperature or moisture is the more important geographic factor. Neither do we hope to erect a stable system of geographic divisions upon either of these bases. When we recall that for North America alone not less than sixty different proposals of geographic zones and regions have been published during the last century, the futility of the point of view which disregards all but one or two climatic factors and emphasizes boundary lines, must be apparent. But we shall be still more impressed with the inadequacy of these proposals if we attempt to relate the actual distribution of plants or plant formations to these "regions."

Recently there has been a rapid increase of local ecological studies in which the successional processes of vegetation have been emphasized. These studies have apprehended to a greater or less extent the dynamics of the habitat and the plant formation. The separation of the local vegetation into stages has assumed the dominance in each, of a distinct complex of environmental factors. The occurrence of distinct boundaries has neither been assumed nor insisted upon.

Local studies, however, can not lead to general conceptions of vegetation unless compared and united into larger units. This brings us to the fact that the larger units generally recognized are transcontinental zones and regions. But zones and regions are static entities. They are developed upon assumptions wholly different from those upon which the local studies have been founded. Usually in zonal classification temperature is recognized as all-important and rainfall an unfortunate disturber of symmetry. Not a few are based upon phenological assumptions long since proved untenable or still awaiting experimental evidence. In other words, the succession of local plant formations which has consciously depended upon changes in the concomitant action of many soil, climatic and historical factors, is made to fit into a larger unit whose fundamental basis is a single or at most two climatic factors. It is to be noted further that the problem most debated in connection with zonal arrangements is the boundary; that the term "zone" implies uniformity of structure and homogeneity of composition. But the most striking fact about the geographic distribution of individual species is their dominance in some region and their decline in importance and frequency as we depart thence in any direction. Plant formations in their distribution show the same phenomenon. Further, it appears that the optimum areas of scores and hundreds of species nearly coincide. In brief, actual plant distribution, through its lack of uniformity and homogeneity, its tendency to concentric dispersal, and the coincidence of the optimum areas of many species, seems to demand larger units in harmony with the processes, structure, composition and origin of their components. Whether we choose to call them "centers of dispersal" is of small moment, as compared with the recognition of the fact that zones and their sub-divisions are not natural organizations of plants or plant formations. Of course, this criticism does not refer to the use of the very convenient expressions of certain spatial and temperature concepts, viz., torrid, temperate and polar zones.

The unsatisfactory character of zones as a basis for classification is felt also by students of climatology. Especially is this true of the classification of the climatic types prevailing on continents. The schemes of Hult (1892–3), Koppen (1900), Supan (1903) and Herbertson (1905) are especially interesting in this connection.[2] Further, the provinces pointed out by Supan for North

[2] Ward, R. DeC. "Classification of Climates," *Bull. Amer. Geog. Soc.*, 38: 401–412, 465–477, 1906.

America show a remarkable coincidence with the natural vegetation centers. If future work both on climate and plant distribution should bring these fundamentally different view-points into essential agreement we should have the possibility of a completely dynamic and genetic system of vegetation and climatic units.

2. *Sources of Error in Applying Climatic Data.*—One of the sources of confusion in the use of the climatological data supplied by the Weather Bureau, in connection with vegetation studies, lies in the placement of the instrument shelter. The data derived recently by means of recording instruments placed in various topographic situations, show such great comparative variations, that the applicability of meteorological records made under the conditions represented by some of the weather stations may be called into question. Fortunately descriptions of the climatological stations of the United States are now available[3] and selection of stations which truly represent the conditions of at least one local habitat may be made.

A second source of error in the comparison with vegetation of climatic data as represented on charts is the fact that the means do not always represent actual local conditions, but may have been corrected for altitude above sea level. Such corrections, however, have not been made, except in the case of the barometric pressure maps, in the recent climatological bulletin of the Weather Bureau.

3. *Recording Instruments for the Measurement of the Climatic Factors.*—The increasing number of those who are attempting to secure by means of recording instruments, habitat data regarding temperature, relative humidity, etc., is the most hopeful sign of progress in the solution of the climatic problems of plant distribution. We now have fairly satisfactory recording instruments for temperature, humidity, rainfall and sunshine. The porous cup atmometer recently added to this list places

---

[3] Henry, A. J. "Climatology of the United States," Bull. Q, U. S. Dept. Agric., Weather Bureau, 1906.

at our disposal a recording instrument whose importance can not be overestimated. Because of its directly applicable data, its slight cost and ease of manipulation, it may well take precedence in comparative habitat investigations.

The greatest desideratum in the way of habitat study now seems to be an instrument for the measurement of light values. It seems probable that the effects of the varying light intensities and qualities in the habitat are generally underestimated at the present time. The comparative studies already made with actinometers and photometers are suggestive, but the value of the data as indicative of relative light conditions from the standpoint of vegetation is open to serious question. Thus far photographic papers have been most generally used. Aside from the high percentage of error attending the matching with standards of the colors developed, these papers are almost wholly affected by the most refrangible rays of the visible spectrum. Plant functions in general find their optima among the least refrangible rays. Owing to selective absorption, a decrease in the intensities of one portion of the spectrum does not necessarily imply a similar decrease throughout. The objection urged against photographic paper also holds for the use of other substances which develop precipitates or gas pressure under the influence of light. Unless papers can be devised which have an increased range of sensitiveness and which can be used in connection with color screens, the continuance of actinometric measurements in habitats seems almost a gratuitous pursuit.

Naturally the spectro-photometer has been suggested for overcoming this difficulty. By means of photographic methods, in which a diffraction grating is used for the dispersion-piece and photographic plates of known sensitivity to the various light rays, more accurate results might be obtained. The difficulties of manipulation, however, seem to preclude the use of this method at the present time.[4]

The method suggested by Zederbaur of using a spectrophotometer in connection with colored prisms and a standard lamp has been hailed by some as a solution of this problem.[5] It also involves several important sources of error, but these may not prove to be insuperable. This method has the great advantage over the actinometer in that it takes into account light quality. With certain modifications, some of which are suggested by Zederbaur, this instrument may prove to be a step toward a better means of light measurement.

4. *Some Climatic Problems of Vegetation.*—But even if the time is approaching when it may be possible to obtain both qualitative and quantitative estimates of the climatic factors related to vegetation processes, we should regard this merely as a preliminary to more important investigations.

We have as yet almost no observational or experimental data from a modern point of view, on geographic variation as related to climate. The reports concerning the results of the cultivation of certain varieties of agricultural and horticultural plants suggest a large field for the application of experimental methods.

A fundamental consideration in experimentation along this line is the use of pedigreed plants. It seems possible that many of the discordant results obtained by physiologists may be traced to physiological races within the species. The use of seeds from the same plant, branch, or fruit is not sufficient caution unless the pollination has been guarded. Where the growth of such large numbers of plants as would be essential to an experiment in geographic variation is necessary, the results could have little value unless the plants used had been analyzed by scientific plant-breeding methods and been shown to consist of an elementary species or variety. Too much insistence can not be placed on this point. The use of homogeneous material is an indispensable prerequisite.

---

[4] Wallace, R. J. "Studies in Sensitometry," *Astrophysical Journal*, 25: 116, 1907.

[5] Zederbaur, C. "The Light Requirements of Forest Trees and the Methods of Measuring Light." English translation. *Forestry Quarterly*, 6: 254, 1908.

If the experiments are to contribute to the better understanding of the greater vegetation units the experiment stations will need to be critically located.

Probably the most promising field for experimentation at the present time is the investigation of the processes of vegetation. There are so many vague notions and dogmatic statements regarding the processes of competition, migration, adjustment, etc., in relation to the climatic factors, that the rewards for pioneer work will be ample. Here again the methods and materials must be carefully considered. In certain of these problems pedigreed (or better perhaps standardized) plants will give far more definite conclusions than those whose composition is unknown. In others, the more nearly we approach actual habitat conditions and investigate actual habitat processes, the more useful will be the results.

Experiments thus guarded may lead not only to a better understanding of vegetation, but they will also contribute to the science of evolution. If the methods used will bear inspection both from the standpoint of the process of heredity and from the processes of vegetation, natural selection and adaptation may be resolved into processes of more definite meaning.

The recognition of the importance of the results of ecological investigations in the practice of agriculture, horticulture and forestry has added much to their intrinsic interest. Some of the problems are perhaps beyond the reach of the individual worker. Fortunately there are several institutions in the United States within whose scope these problems lie. That they have already begun the publication of contributions to this field is the best evidence that both the larger and the smaller problems of the climatic relations of vegetation will be more adequately studied in the near future.